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(54) Abstract Title: **Computer connection apparatus and devices**

(57) Cables, connectors, adapters and associated methods are described for connecting a computer to a device using standard video connectors to supply video and audio signals. The cable includes a first standard video connector 230 and a second standard video connector 242 and a first audio connector 244 at a second end of the cable. A video signal transmission path is provided between video terminals of the first and second video connectors; and an audio signal transmission path is provided between the first audio connector and redundant pins which are used as audio terminals of the first standard video connector. The cable can include a second audio connector 246 and audio signal path. Also described is a KVMA switch including a video connector configured to handle both audio an video signals. An adapter for PS/2 and USB style connectors and cables is also disclosed as well as a method for determining the type of device connected to a KVM or KVMA switch.

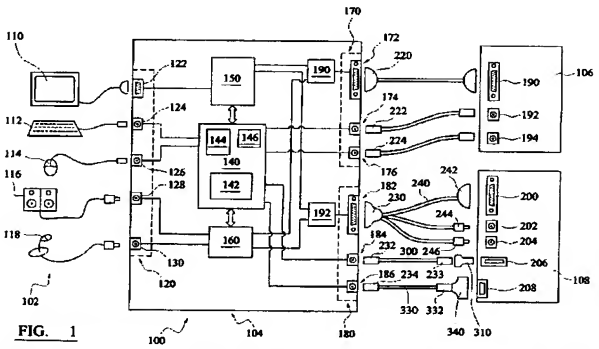

FIG. 1

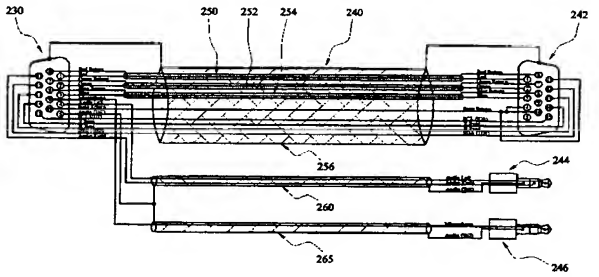

FIG. 2

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

This print takes account of replacement documents submitted after the date of filing to enable the application to comply with the formal requirements of the Patents Rules 1995

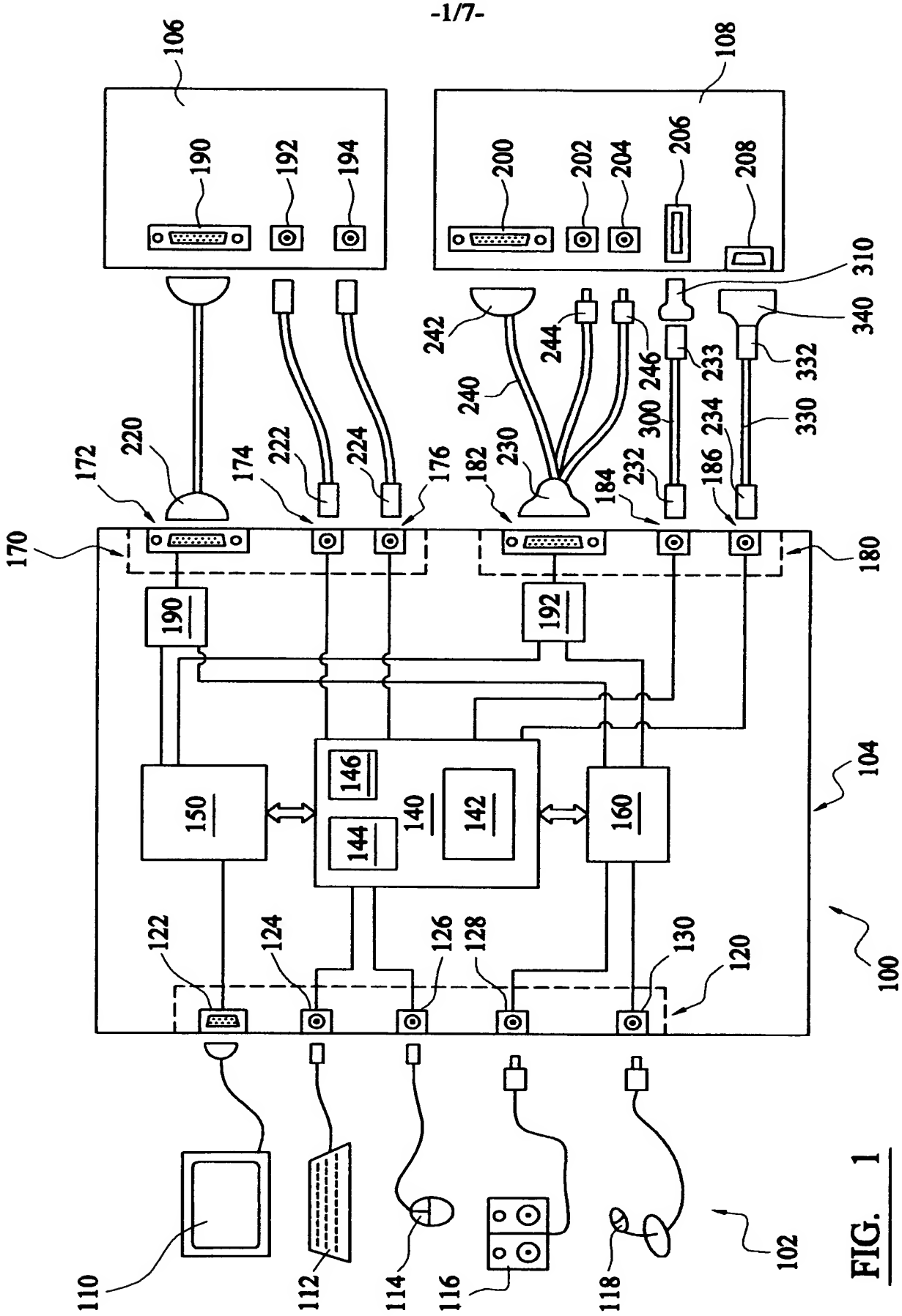

FIG. 1

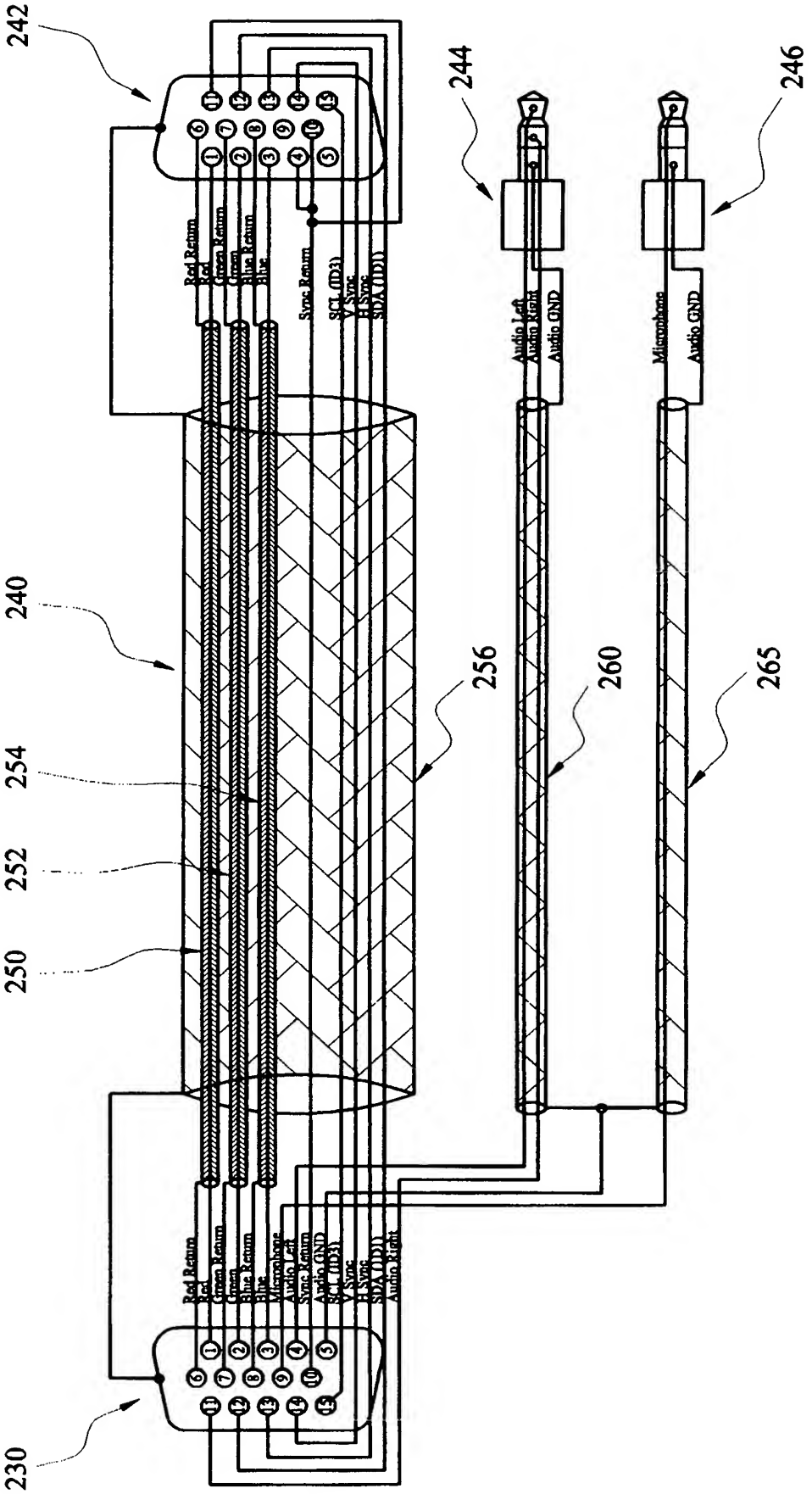

FIG. 2

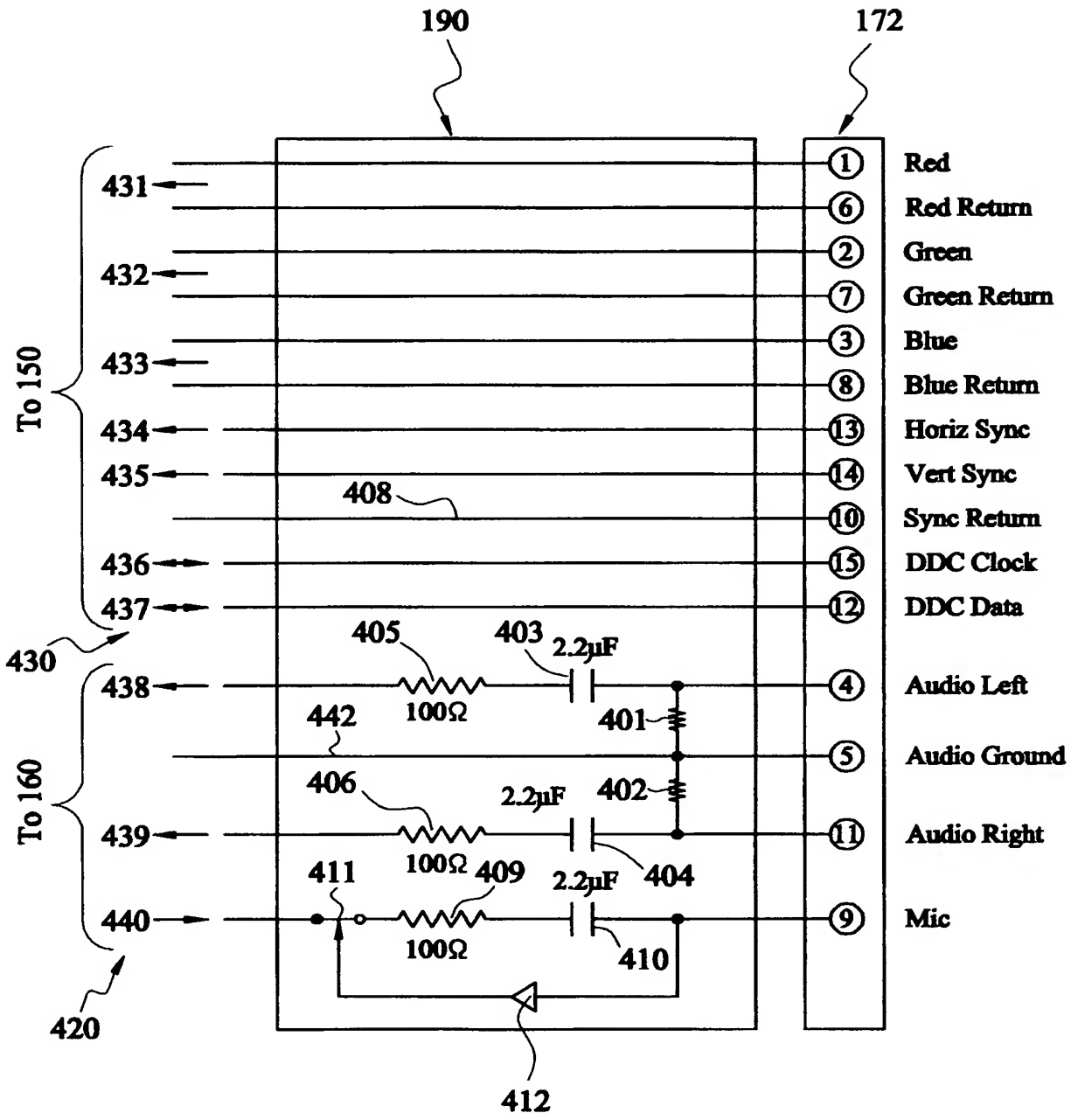

FIG. 3

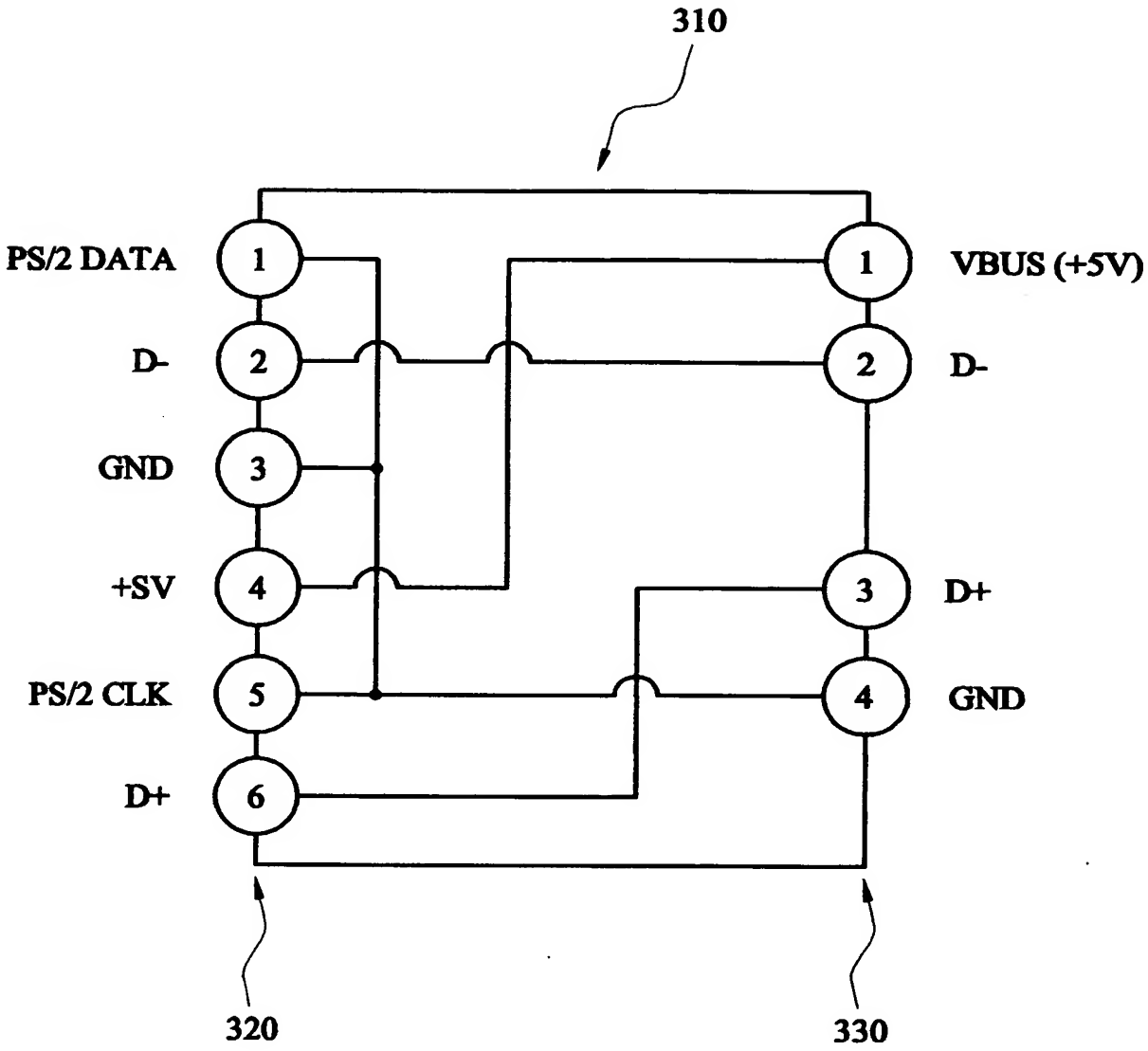

FIG. 4

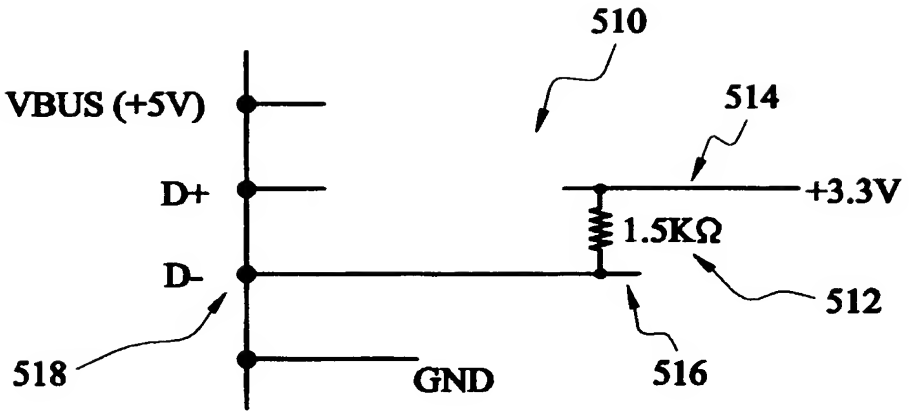

FIG. 5A

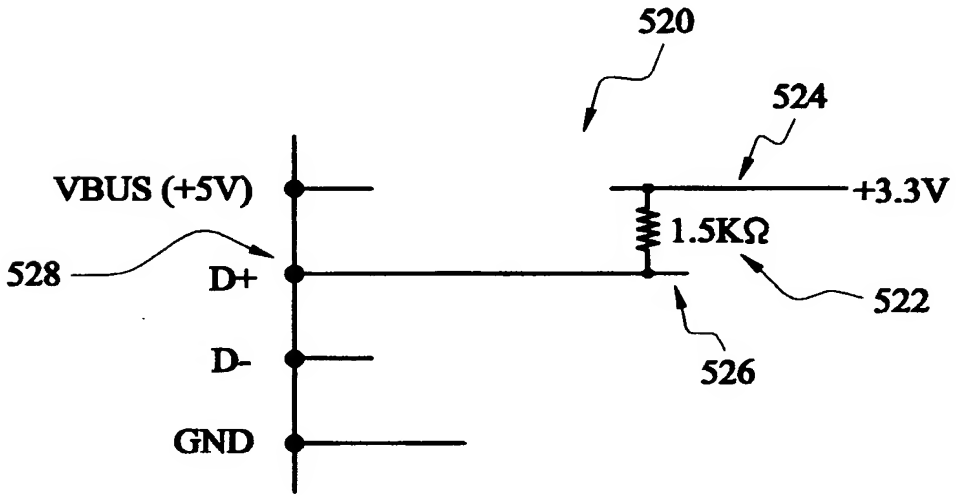

FIG. 5B

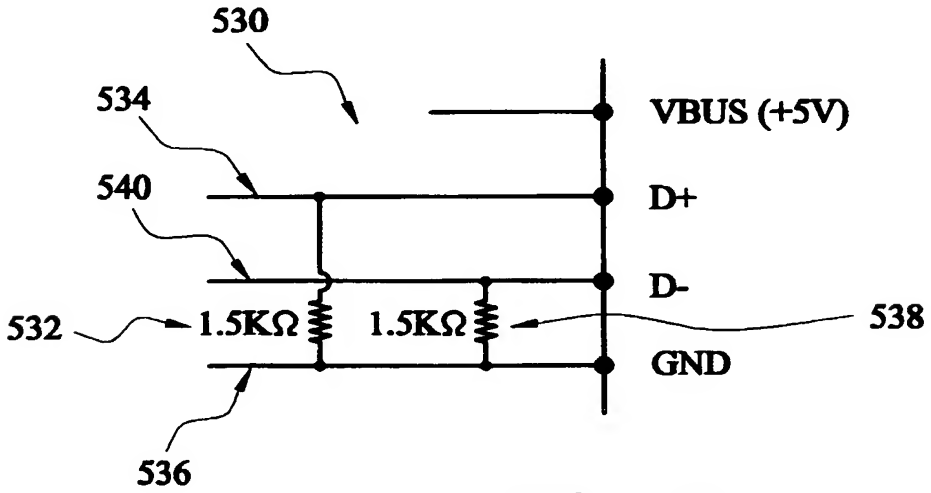

FIG. 5C

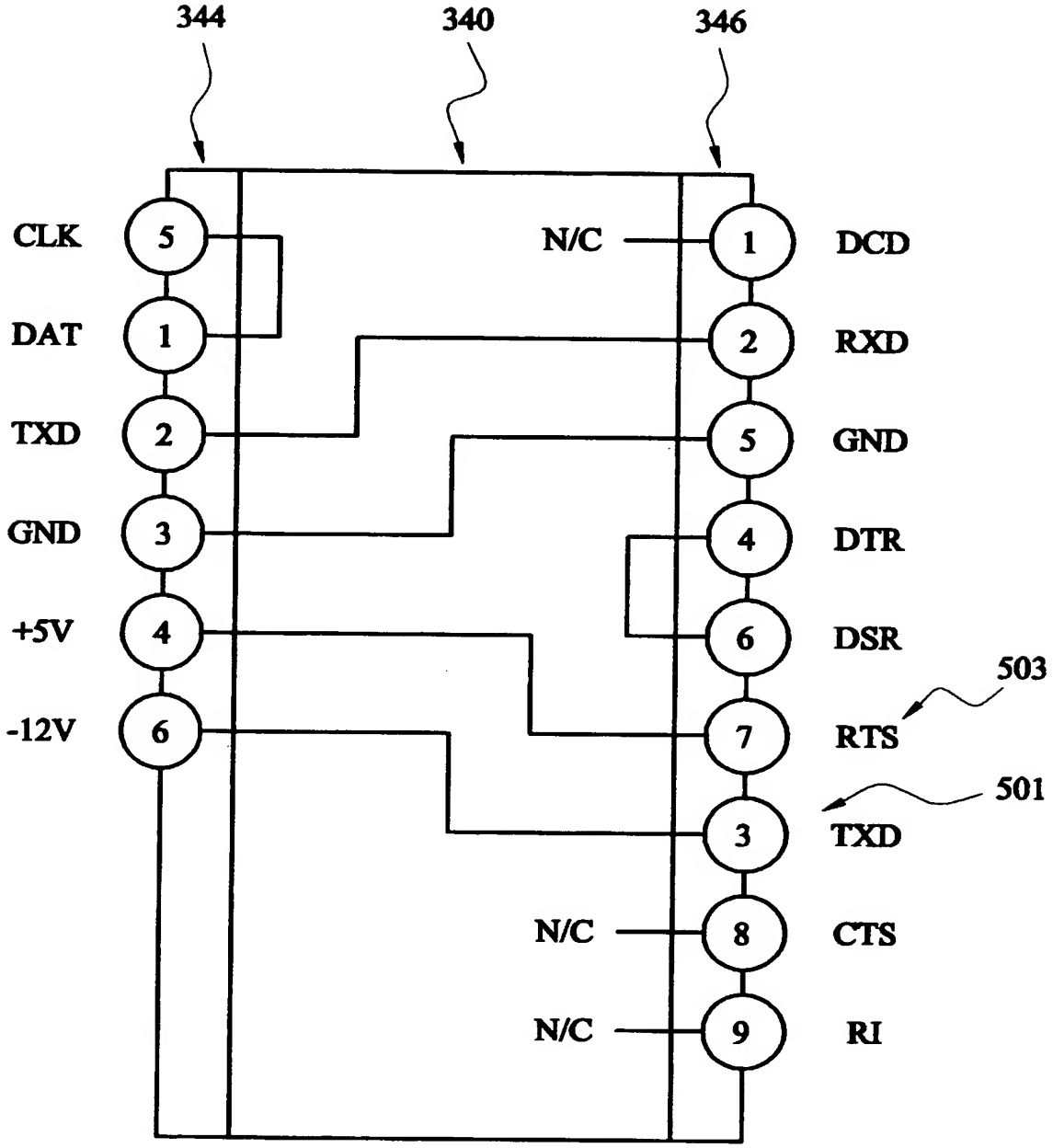

FIG. 6

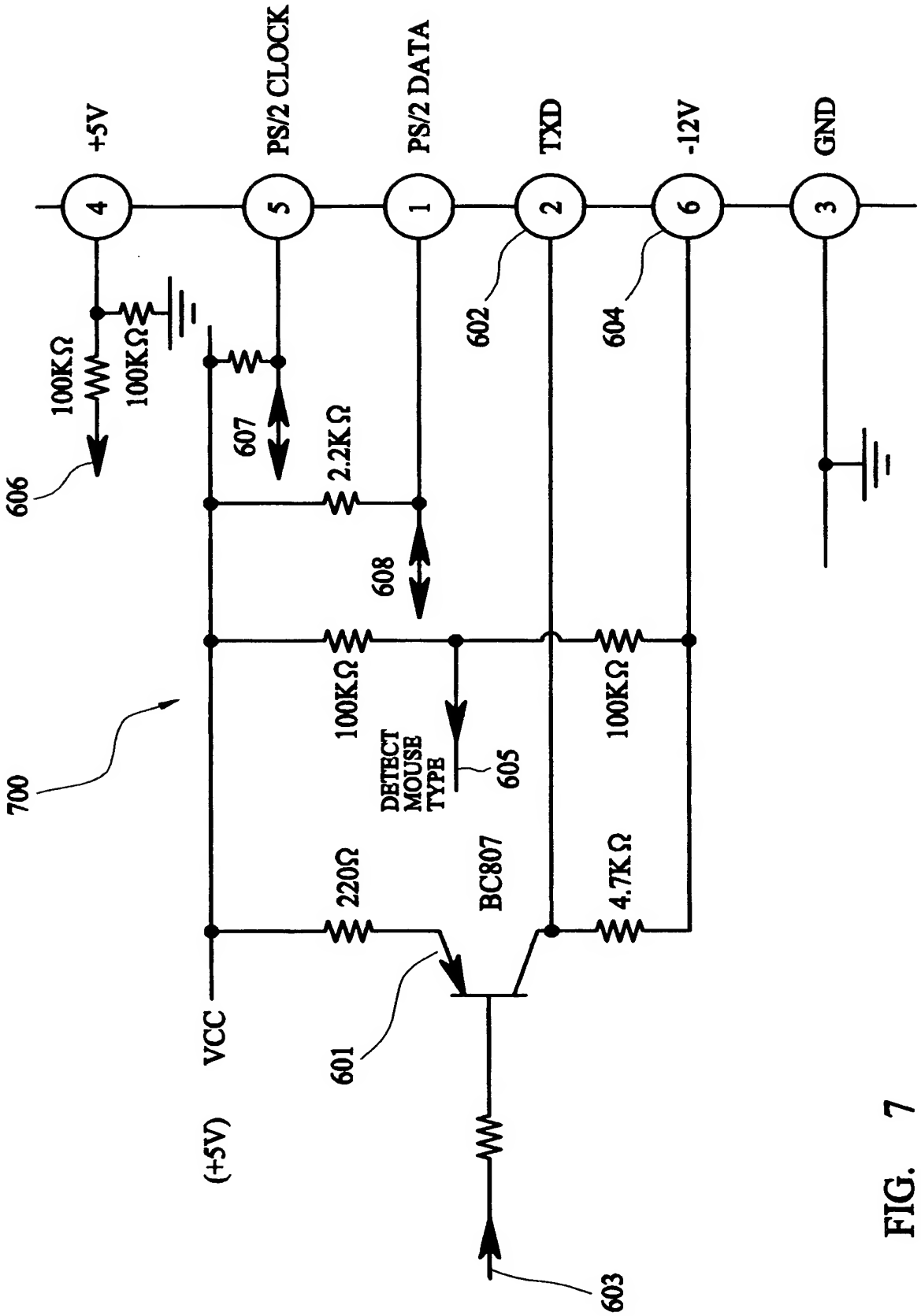

FIG. 7

Computer Connection Apparatus and Devices

The present invention relates to connecting a computer and peripheral devices, and in particular to cables, connectors and switching devices, and related methods, enabling computers to be connected to peripheral devices using standard connectors.

Computers can support a number of input and output peripheral devices, including keyboards, mice, monitors, audio speakers and microphones. Electrical signals for such devices are usually transmitted between a computer and the peripheral devices over respective cables connected to respective ports of the computer by respective connectors. Different connectors are used depending on both the type of peripheral and also the data format and protocol required in order to communicate with the peripheral.

For example, the Universal Serial Bus (USB) is a serial bus standard commonly used to allow personal computers to communicate with keyboards, mice, printers and other devices. Another example is PS/2 which is another transmission protocol, which can be used to allow personal computers and peripheral devices to communicate. PS/2 is a bi-directional point-to-point protocol which uses clock and data signals, and in which data is transmitted sequentially, one bit at a time. However, although both PS/2 and USB are standard protocols, they use physically different connectors and also different signaling protocols and data signals. Therefore a PS/2 mouse cable having a PS/2 connector cannot be connected directly into a USB port. Further, the PS/2

mouse would not work directly with a USB port as the USB and PS/2 standards are different.

PS/2 is an older standard than USB. There are therefore many computers with PS/2 ports but not USB ports in existence. However, there are an increasing number of computers with USB ports but not PS/2 ports. Therefore there can be difficulties in trying to use computers having different ports with a common set of peripherals.

For example, KVM (keyboard, video and mouse) and KVMA (keyboard, video, mouse and audio) switches allow a number of computers to be selectively connected to a common set of keyboard, video display, mouse and audio devices, such as speakers and microphones. The KVM or KVMA switch has a computer port for each computer to be connected to the switch. Each computer port has a number of connectors at which the keyboard, monitor, mouse and any audio cables from the computer are connected.

However, in order to allow either a PS/2 and USB computer to be connected to a computer port of a KVM or KVMA switch, both a USB keyboard and mouse connector and separate PS/2 connectors for both a keyboard and a mouse need to be provided. If audio is also to be supported, then microphone and speaker connectors are also required. This results in a computer port with a large number of connectors which is therefore expensive to provide. However, standard USB and PS/2 cables can be used to connect a computer to the KVM or KVMA switch, although separate sets of cables with PS/2 and USB connectors are required.

In order to reduce the number of connectors, a single multi-pin connector, such as a 25-way D-type connector, can be used in which the keyboard, monitor, mouse and audio signals are presented on different pins of the connector. However, such a combined connector requires a customized cable with a 25-pin connector at one end and separate keyboard, video and mouse connectors at the other end for connection to the computers. Also, the 25-way connector is not a standard connector and so cannot be used with standard cables if the customized cable is not available. Also the pin configurations on different KVM or KVMA switches tend to be different and so a different customized cable is required for different switches. Customized cables are also more expensive than standard cables. Hence, although this approach reduces the number of connectors required on a KVM or KVMA switch, it tends to be more expensive and to reduce the flexibility and ease of use of systems in comparison to systems using standard connectors and cables. Also such a system still requires separate sets of PS/2 and USB cables to be used.

It would therefore be advantageous to be able to provide KVM and KVMA switches with a small number of connectors while being able to use a small number of standard cables and connectors.

According to a first aspect of the invention, there is provided a cable for connecting a computer to a device having a standard video connector, the cable comprising: a first standard video connector at a first end of the cable for connecting to the device, a second standard video connector and a first audio connector at a second end of the cable for connecting to the computer, a video signal

transmission path between video terminals of the first and second video connectors and an audio signal transmission path between the first audio connector and audio terminals of the first standard video connector.

The standard video connector is configured such that it can provide both video signals and audio signals. The video connector is a standard video connector in that it can be used with standard computer video connectors and so can be used both with devices which can extract both the audio and video signals and also those devices which can extract the video signals only. Of the terminals, or pins, available in the standard video connector, a number of redundant terminals (i.e. video terminals physically present but not necessary to provide sufficient video signals for a video display device to function) are used as terminals to supply audio signals. Therefore a standard connector can be used to supply both video signals from video terminals and audio signals from audio terminals of the same standard video connector.

The audio signal transmission path can provide a path for speaker signals to speaker terminals of the audio terminals.

The cable can include a further audio connector at the second end of the cable and a further audio signal transmission path between the second audio connector and audio terminals of the first standard video connector. The further audio signal transmission path can provide a path for microphone signals to microphone terminals of the audio terminals.

The audio terminals can include a set of speaker terminals and a set of microphone terminals. Some of the audio terminals can be common to the sets of speaker terminals and microphone terminals. The or each audio connector can be an audio jack.

The audio signal path and/or further audio signal path can be in the form of a shielded cable. The video signal transmission path can be in the form of a shielded cable. The cable can comprise a separate video signal cable, speaker cable and microphone cable bundled into a single cable. The cable can further be bundled with at least one peripheral cable for connecting a computer to a peripheral device. Preferably the peripheral cable includes a PS/2 style connector at each or either end.

The first standard video connector can be a 15 way video connector. Four of the pins can be used to supply audio signals and the remaining pins can be used to supply video signals. The connector can have separate analogue and digital ground pins. The analogue ground pin can be an audio signal ground and the digital ground pin can be a video signal ground. The audio signal ground can be common to speaker and microphone signals.

The audio terminals of the connector can include at least one terminal corresponding to a video display data signal terminal. Preferably, the or each terminal corresponds to a DDC monitor ID bit signal. Preferably two terminals corresponding to DDC monitor ID bit signal terminals are used as audio terminals. The two video display data terminals can be used to supply two different audio channel

signals, which are preferably left and right speaker signals.

The audio terminals can include a terminal corresponding to a power supply signal terminal. The power supply signal terminal can be used to supply a microphone signal.

The audio terminals include a terminal corresponding to a ground terminal. The audio terminals can include a set of speaker audio terminals comprising a first audio channel terminal, a second audio channel terminal and an audio ground terminal. The audio terminals can include a set of microphone terminals which comprise a microphone signal terminal and a microphone ground terminal. The microphone ground terminal can be common with the audio ground terminal.

The cable can have no signal path between a video terminal of the second standard video connector corresponding to a ground terminal and the first standard video connector. In this way the corresponding terminal of the first video connector can be used as an audio terminal.

The video terminals of the second standard video connector corresponding to video display data signal terminals can be connected to a ground terminal of the second standard video connector. In this way the display data signal terminals are held at a signal level corresponding to a signal level expected by the computer and so the computer does not detect an error state.

According to a further aspect of the invention, there is provided a method for transmitting video and audio signals

between a computer and a device having a standard video connector, comprising providing a video signal transmission path between a computer video connector and video terminals of a standard video connector and providing an audio signal transmission path between an audio connector and audio terminals of the standard video connector. By using terminals of a standard video connector to supply both video signals and audio signals, a cable with a standard video connector can be used to supply both video and audio signals between a computer and a device having the standard video connector.

The method can comprise providing a further audio signal transmission path between a further audio connector and audio terminals of the standard video connector.

Speaker signals can be provided over the audio signal transmission path. Microphone signals can be provided over the further audio signal transmission path.

The video terminals and the audio terminals of the standard video connector can have separate ground terminals. The audio ground terminal can be common to different audio signals. The audio terminals can include at least one terminal corresponding to a video display data signal terminal. The audio terminals can include at least one terminal corresponding to a power supply terminal.

According to a further aspect of the invention, there is provided an electrical apparatus for handling video and audio signals, including a standard video connector having video terminals and audio terminals and video signal handling circuitry and audio signal handling circuitry, in

which the video signal handling circuitry is connected to the video terminals of the standard video connector and the audio signal handling circuitry is connected to the audio terminals of the standard video connector. In this way both audio signals and video signals to be handled by the apparatus can be supplied to the apparatus via a standard video connector. The apparatus can be a part of a video and audio signal switching device. The apparatus can be a part of a computer port of a KVMA switch.

The audio signal handling circuitry can be connected to at least one audio terminal corresponding to a video display data signal terminal. The standard video connector can have a video ground terminal and a separate audio ground terminal. The standard video connector can have an audio ground terminal common to two different audio signals. The standard video connector can be a 15 way video connector.

According to a further aspect of the invention, there is provided a system comprising a computer having a video connector and at least one audio connector connected to a device according to a previous aspect of the invention by a cable according to a previous aspect of the invention.

According to a further aspect of the invention, there is provided a KVMA switch including video signal switching circuitry, audio signal switching circuitry and at least one computer port comprising a mouse connector, a keyboard connector and a standard video connector, in which the standard video connector includes video terminals in communication with the video signal switching and audio terminals in communication with the audio signal switching circuitry. In this way both audio signals and video signals

can be supplied to the KVMA switch from a computer via a standard video connector.

The KVMA switch can further comprise a peripheral port, including a video connector, a keyboard connector, a mouse connector, a speaker connector and a microphone connector.

The computer port of the KVMA switch can consist of a connector for a mouse, a connector for a keyboard and a standard video connector. In this way only three connectors are required in order to supply keyboard, mouse, video and audio signals to the KVMA switch. This helps to reduce the size of a KVMA switch compared to a KVMA switch having more connectors in its computer port.

The KVMA switch can include a plurality of computer ports, each consisting of a mouse connector, a keyboard connector and a standard video connector.

According to a further aspect of the invention, there is provided an adapter comprising a PS/2 style connector at a first end and a USB style connector at a second end, in which terminals of the PS/2 connector corresponding to PS/2 data and clock signals are connected to a ground terminal of the USB connector. In this way the adapter can be used to automatically signal the nature of the device connected by the adapter.

According to a further aspect of the invention, there is provided an adapter comprising a PS/2 style connector at a first end and a USB style connector at a second end, in which terminals of the USB connector corresponding to USB data signals are connected to terminals of the PS/2

connector not corresponding to PS/2 data and clock signals. In this way the USB and PS/2 signals used to transmit data under the PS/2 and USB protocols are provided on different terminals which simplifies subsequent handling of the signals.

According to a further aspect of the invention, there is provided a method for determining whether a PS/2 or USB device is connected to a PS/2 style connector, comprising monitoring the signals on terminals of the PS/2 style connector corresponding to the PS/2 data signal and the PS/2 clock signal and determining that a PS/2 device is not connected to the connector if the PS/2 data signal and PS/2 clock signals are the same for a threshold period of time.

The method can include determining that the PS/2 data and clock signals are both low. The threshold period of time can be greater than substantially 150 microseconds. The threshold period of time can be greater than substantially 200 microseconds.

An embodiment of the invention will now be described in detail, by way of example only, and with reference to the accompanying drawings, in which:

Figure 1 shows a schematic block diagram of a KVMA system incorporating aspects of the present invention;

Figure 2 shows a schematic wiring diagram of a combined video and audio cable according to an aspect of the invention;

Figure 3 shows a schematic circuit diagram of a signal conditioning circuit part of the KVM system shown in figure 1;

Figure 4 shows a wiring diagram of a PS2/USB adapter part of the system shown in figure 1;

Figures 5A, 5B and 5C respectively show circuit diagrams illustrating the use of pull up and pull down resistors for handling USB protocol signals;

Figure 6 shows a wiring diagram of a PS2/RS232 adapter part of the system shown in figure 1; and

Figure 7 shows a circuit diagram of interface circuitry for a PS/2 port of the KVMA switch shown in figure 1.

Similar items in different figures share like reference numerals unless indicated otherwise.

With reference to figure 1 there is shown a KVMA system 100, including a user console 102, a KVMA switch 104, a first computer 106 and a second computer 108. Although only two computers are shown in the system of figure 1, this is for the sake of clarity only and it will be appreciated that more than two computers can be used in the system with corresponding changes to the KVMA switch to accommodate more than two computers.

User console 102 includes a monitor 110, which provides a display device, a PS/2 style keyboard 112, a PS/2 style mouse 114, a pair of stereo loudspeakers 116 and a microphone 118. KVMA switch 104 allows the user console peripherals 102 to be used commonly to operate a particular one of a plurality of computers via the KVMA switch 104.

KVMA switch 104 has a user port 120. The user port includes connectors by which the user console peripherals are connected to the KVMA switch. The user port includes a standard 15-way VGA D-type socket 122 which accepts a

matching 15-way VGA D-type connector at an end of the monitor cable. The user port also includes a PS/2 type 6-pin mini-DIN socket 124, 126 for accepting each of the PS/2 type 6-pin mini-DIN plugs of the keyboard cable and the mouse cable. A 3.5mm jack socket 128 is provided for the 3.5mm jack connected to the end of the stereo speaker cable as well as a 3.5mm jack socket 130 for the 3.5mm jack connected to the end of the microphone cable.

KVMA switch 104 includes a microprocessor based controller circuit 140 which is in communication with and controls a video signal switching circuit 150 and an audio signal switching circuit 160. Controller circuit 140 includes a first microprocessor 142 which is used to control the overall operation of the KVMA switch and which also handles the processing, routing and generation of PS/2 type signals and data as required. A suitable device is the PIC 16F877 microprocessor, as provided by MicroChip Technology Inc. Control circuit 140 includes a second microprocessor 144 which handles USB type signaling and data. A MC68HC908JB8 microprocessor as provided by Motorola Inc is a suitable device. A switching device 146 is also provided to selectively connect the second microprocessor to the active computer port as will be described in greater detail below. The PI5C3253 switch as provided by Pericom Semiconductor Corp is a suitable switching device.

The KVMA switch includes a first computer port 170 and a second computer port 180. Each port includes three connectors. A 15-pin high density D-type connector 172, 182 is provided to accept a standard 15-pin D-type connector 220, 230 attached to a computer video cable. A standard 6-pin mini-DIN keyboard connector 174, 184 is provided for

accepting a standard 6-pin mini-DIN connector 222, 232 attached to a keyboard cable of a computer. A standard 6-pin mini-DIN mouse connector 176, 186 is provided for accepting a standard 6-pin mini-DIN connector 224, 234 attached to a mouse cable of a computer.

KVMA switch 104 includes respective video and audio signal conditioning circuits 190, 192 each in communication with a respective video connector 172, 182. The signal conditioning circuits 190, 192 are in communication with the video switching circuit 150 and audio switching circuit 160 and handle video signals to and from the video switching circuit and audio signals to and from the audio switching circuit. The audio switching circuit 160 is in communication with the common audio connectors 128, 130 and the video switching circuit is in communication with the common video connector 122. The computer keyboard 174, 184 and mouse 176, 186 connectors are in communication with the main control circuit 140, which in turn is in communication with the common keyboard 124 and mouse 126 connectors.

First computer 106 includes a standard 15-pin D-type video port 190, a standard 6-pin mini-DIN PS/2 type keyboard port 192 and mouse port 194. Second computer 108 includes a standard 15-pin D-type video port 200, a 3.5mm jack audio line out socket 202, a 3.5mm jack audio line in socket 204, a 4-pin USB connector port 206, at which either a mouse or a keyboard USB connector can be attached, and an RS232 serial port 208 to which an RS232 connector can be attached.

KVMA switch includes other circuitry as used in conventional KVMA switches, but which has not been described or shown so as not to obscure the present invention. For example, the

KVMA switch also includes a key switch to enable the user to select the required computer and a visual display to confirm to the user the selected computer. The control circuitry 140 is configured to process and interpret the keyboard and mouse data and supports keyboard hot key switching of the selected computer.

The first microprocessor 142 handles the signaling of PS/2 mouse and keyboard data and signals and is in communication with the second microprocessor 144 which handles USB keyboard and mouse data and signaling. The USB microprocessor 144 also handles the conversion of PS/2 and USB data. In particular it handles the conversion of PS/2 keyboard and mouse data received via common keyboard 124 and common mouse 126 connectors into USB keyboard and mouse data for supply to any computer connected to the KVMA switch which requires USB format keyboard and mouse data. The USB microprocessor 144 also emulates the presence of a USB keyboard and mouse by sending appropriate USB signals to a connected USB computer. As the MC68HC908JB8 only has one USB connection (i.e. one set of D+ and D- USB data signals), switch 146 is used to supply the USB signals to the active computer port 170, 180. This avoids the need to use a separate USB processor for each computer port.

The first microprocessor controls the general operation of the KVMA switch, including reading the state of the key switch, or detecting hot key signals, writing to the display and controlling the routing of video and audio signals through the respective switching circuits, responsive to a switching request signal.

The first computer 106 does not support audio and the video signal is supplied to the KVMA switch via a cable including a standard 15-way D-type video connector on each end. The video connector 172 of the KVMA device is configured to co-operate with the signal conditioning circuit 190 such that the KVMA switch will operate correctly with a conventional video cable and connectors as will be described in greater detail below. Similarly, the keyboard and mouse signals are supplied to the KVMA switch using conventional cables having standard 6-pin mini-DIN PS/2 style connectors. Hence a legacy computer can be used with the KVMA switch using standard cables. The separate cables can be bundled into a single cable.

The second computer 108 does support audio and also has a USB port 206 and an RS232 serial port 208, rather than PS/2 style connectors. The KVMA switch allows the same three standard connectors of the KVMA computer port 180 to be used to handle audio for computer 108 and also to accept signals from different computer mouse and keyboard connectors 206, 208.

Figure 2 shows a wiring diagram of a combined video and audio cable 240. Cable 240 includes a standard 15-way D-type connector 230, 242 at each end. The cable also includes a first standard 3.5mm audio jack 244 for the speaker audio signal and a second standard 3.5mm audio jack 246 for the microphone audio signal.

The conventional pin assignment for a 15-way VGA connector supporting display data channel version 2 (DDC2) signaling is as follows:

Pin	Signal
1	Red video (analogue colour signal)
2	Green video (analogue colour signal)
3	Blue video (analogue colour signal)
4	Monitor ID bit 2
5	Ground/return
6	Red video return
7	Green video return
8	Blue video return
9	+5V supply
10	Sync return
11	Monitor ID bit 0
12	Bi-directional data (DDC signaling)
13	Video horizontal sync
14	Video vertical sync
15	Data clock (DDC signalling)

The combined video and audio cable can use a single standard 15-way connector to connect to the KVMA as in many instances a number of the pins are not required in order to successfully transfer the video signal.

In cable 240, the red, green and blue video colour signals are each connected by a shielded wire 250, 252, 254 between pins 1, 2 and 3 and the red, green and blue return signals are connected by the shielding of each wire between pins 6, 7 and 8. The sync return signal is connected conventionally between pins 10. Pins 12, 13, 14 and 15 are connected conventionally to supply the DDC signalling bi-directional data signal, horizontal synchronization, vertical synchronization and DDC data clock signals respectively.

Originally pins 11, 12, 4 and 15 were four ID bit pins, intended to provide static data bits (logic 0 or logic 1 states) to enable a computer to determine the type of monitor that was connected. However, that mechanism has been superseded by the DDC (Display Data Channel) system and pins 12 and 15 are now allocated to the DDC data and clock signals. Modern computers tend to be able to set the required video resolution settings without using the ID monitor bits and the DDC is used by many graphics cards to detect the type of monitor. Therefore ID bit pins 4 and 11 tend not to be required and are now redundant. At the computer connector 242, pins 4 and 11 are connected to pin 10 which provides a digital ground. Thereby pins 4 and 11 of the computer connector 242 are held at logic 0 which is an expected state of pins 4 and 11 and so acceptable to the computer 108. Pin 5 is allocated as an analogue ground and so is unconnected at the computer connector 242.

Conventionally pin 9 is used to supply the DDC +5V power signal to a monitor's DDC circuitry. However, as the video cable is between the computer and the KVMA switch, it is not necessary for the computer to provide the DDC power supply and the KVMA switch can provide the +5V DDC power supply signal from connector 122 to the monitor 110. Therefore pin 9 is also left unconnected in the computer connector. The wires carrying the video signals are also enclosed in a shield 256.

At the KVMA switch end of the cable 240, pins 4, 5, 9 and 11 of the KVMA connector 230 are used to supply audio signals to the KVMA switch via the standard video connector 230. A shielded stereo loudspeaker cable 260 has audio jack 244 at one end and is connected at the other end to the video

connector 230. The loudspeaker cable 260 includes a first wire carrying the left audio signal connected between the jack 244 and pin 4 of the connector. A second wire carries the right audio signal between the jack 244 and pin 11 of the video connector 230. The shield is connected to a common analogue audio ground via pin 5 of the video connector. A shielded microphone cable 265 includes a wire connecting the microphone jack 246 to pin 9 of the video connector 230. The microphone cable shielding is also connected to the analogue audio ground pin 5.

To achieve good audio quality it is necessary to ensure that noise from digital signals (e.g. microprocessor I/O signals, the horizontal and vertical synchronisation signals) does not appear on analogue audio signals. Even small levels of noise introduced onto analogue audio signals can often be heard by the human ear which is very sensitive to low levels of noise. To ensure that the minimum amount of noise appears on the analogue audio signal pin 5 is used to provide an analogue audio ground. The signal conditioning circuits 190, 192 are designed to minimise the amount of digital signal noise that is introduced onto the analogue ground thereby maximising the audio quality.

To ensure that the minimum level of digital signal noise is present on the analogue audio signals, the digital circuitry of the KVMA switch is segregated from the analogue circuitry of the KVMA switch and the interface between the two circuits is filtered. The power supply (i.e. the +5V power signal) to the analogue and digital circuits is filtered using a standard filter design, e.g. an inductor feeding a

smoothing capacitor. The ground for the digital circuitry is connected to the ground for the analogue circuitry at the interface between the two and at a single point only. Connecting at a single point ensures that there is no mutual inductance between the digital and analogue ground circuit board connections. This helps prevent noise voltages from one circuit being introduced onto the other. Keeping the digital and analogue circuits separate to reduce noise means that the video connector 230 should have separate audio and digital ground pins. The ground pins (pins 10 and 5) are connected at a single point only within the KVMA switch.

The two audio cables 260, 265 can be bundled with the video cable and the audio and video cable can be bundled with the keyboard 300 and mouse 330 cables, to provide a single cable with three connectors at the KVMA switch end and five connectors at the computer end.

Figure 3 shows a circuit diagram of the signal conditioning circuit 190. Signal conditioning circuit 192 is identical. The signal conditioning circuit is connected to D-type connector 172. The pins of the D-type connector accept video and audio signals from the cable 240 as will be described in greater detail below. A video signal part of the circuit comprises wires carrying the video signals which are then supplied to the video switching circuit 150. The red 431, green 432 and blue 433 video signals are respectively the voltage difference between the signals on the red, green and blue video signal lines and the respective red, green and blue ground lines. The horizontal sync signal 434, the vertical sync signal 435, the DDC clock

signal 436 and the DDC data signal 437 are the voltage difference between the signal on the respective line and the digital ground signal on line 408. The output 430 from a video signal part of the conditioning circuit is supplied to the video switching circuit 150.

The output 420 from an audio signal conditioning part of the conditioning circuit 190 is supplied to the audio switching circuit 160. The left and right audio signal lines are each connected via a 1.5KΩ resistor 401, 402 to the audio ground signal line. The value of these resistors is chosen to be high enough so that they do not significantly load the audio signals but are low enough so that a computer trying to read the states of monitor ID bits 0 and 2 would detect a logic low level. In practice the number of computers that would need to read these ID bits would be low and so these resistors may be omitted with little effect on the use of the invention.

The left audio signal 438, the right audio signal 439 and the microphone signal 440 are respectively the voltage difference between the signal on the respective corresponding line and the analogue ground signal on line 442. The left and right audio signal lines also each include a 2.2 microfarad capacitor 403, 404 and 100Ω protection resistors 405 and 406 which connect pins 4 and 11 of the connector 172 to the audio switching circuit 160. The capacitors 403, 404 ensure that only AC audio signals are fed through to the audio switching circuit 160.

The audio ground and digital ground lines are not linked together within the signal conditioning circuits 190, 192 to avoid mutual inductance between the digital and analogue circuits and hence help prevent digital noise appearing in the audio circuit. Digital noise from the digital and microprocessor circuitry within the KVMA switch is present on the digital ground signal line 408. Connecting the digital and analogue grounds together within the signal conditioning circuits would create multiple links between the digital and analogue ground tracks resulting in mutual inductance and digital noise appearing in the analogue audio circuit. As described above, to help avoid this, the digital and analogue grounds are connected at a single point only at the filtered interface between the digital and analogue circuits.

The microphone audio signal line is connected to pin 9 of connector 172 via a 2.2 microfarad capacitor 410 and a 100Ω protection resistor 409. Capacitor 410 prevents a 5V DC signal being fed to the audio circuit if a 5V signal is present on pin 9. The 100Ω resistor 409 limits the current that can be supplied from the audio switching circuit 160 to pin 9. If 5V is present on pin 9, then the 100Ω resistor prevents damage to the audio circuit. If the 100Ω resistor were not present, then the audio signal would be driven directly onto pin 9. A 5V DC signal looks like a short circuit to an AC signal.

In an alternative embodiment, an electrically controlled analogue switch 411 and buffer 412 may be used to switch off the microphone signal when a 5V signal is present on pin 9. However, this may not be required if there are no difficulties with driving the low level (in region of 100mV) microphone signals into the 5V pin, as the protection resistor 409 is limiting the current.

Computer 108 includes a USB output port 206. Cable 300 is standard in that it has a standard PS/2 style 6-way mini-DIN connector at each end 232, 233 and so while it can be connected to the KVMA connector 184 it cannot immediately be connected to the USB port 206. An adapter 310 for converting a PS/2 style 6-pin mini-DIN plug to a USB 4-pin connector is provided.

Figure 4 shows a wiring diagram for the adapter 310. The adapter 310 has six pins 320 of a 6-pin mini-DIN connector at one end and four pins 330 of a USB connector at a second end. Pin 1 of the PS/2 style connector 320 is assigned to the PS/2 data signal, pin 3 to ground, pin 4 to a +5V power signal and pin 5 to the PS/2 clock signal. At the USB end of the adapter, pin 1 is assigned to the USB power supply VBUS (+5V), pin 2 to the USB negative data signal (D-), pin 3 to the USB positive data signal (D+) and pin 4 to ground. The PS/2 and USB pins are connected as follows: 1, 3 and 5 to 4, 2 to 2, 4 to 1 and 6 to 3. Hence the two unused PS/2 pins are assigned to the USB data signals. The PS/2 clock and data signals are connected to ground and the power supply pins are connected to each other.

Figures 5A, 5B and 5C respectively show schematic circuit diagrams illustrating how USB connectors of typical US

peripherals for low speed and high speed USB operation and typical USB computer ports are configured. As illustrated in figure 5A, for low speed USB peripherals, the wiring 510 for the connector for USB signals, includes a 1.5KΩ resistor 512 connected between a 3.3V power rail 514 and the USB D- signal line 516 and connector pin 518. As illustrated in figured 5B, for high speed USB peripherals, the wiring 520 for the connector for USB signals includes a 1.5KΩ resistor 522 connected between a 3.3V power rail 524 and the USB D+ signal line 526 and connector pin 528. As illustrated in figure 5C, the wiring 530 for a computer connector USB signals includes a first 15KΩ resistor 532 connected between the USB D+ signal line 534 and the ground line 536 and a second 15KΩ resistor 538 connected between the USB D- signal line 540 and the ground line 536.

PS/2 signals are typically un-balanced 5V and USB signals are typically balanced 3.3V signals (D+ and D-). For USB devices conforming to USB version 1.1 standard, a high and a low signaling speed are possible. The speed of a peripheral is signalled to the USB host by either connecting a 1.5kΩ pull up resistor between the D+ signal line and a 3.3V power line to indicate a high speed peripheral (figure 5B) or connecting a 1.5kΩ resistor between the D- signal line and a 3.3V power line to indicate a low speed peripheral (figure 5A). In this way, USB connectors can be configured for either high speed or low speed peripherals. KVMA switch peripheral port USB connectors 124, 126 are set to signal low speed peripherals when low speed keyboards and mice are to be attached.

The computer's USB port 206 for USB signals has 15kΩ pull-down resistors connected between the D+ line and ground and

the D- line and ground (see figure 5C). When the computer's USB port is connected to a USB peripheral, the computer monitors the voltage changes on the D+ and D- lines 534, 540 to detect the speed of the USB peripheral. In the case of the KVMA switch 104, low speed mode is signaled to the computer. Current keyboards and mice operate in low speed USB mode, although connectors can be provided for the KVMA switch to allow other peripheral devices to be attached to the KVMA switch at the peripheral port 120.

Owing to the different signaling voltages used by PS/2 and USB it is beneficial to present the PS/2 clock and data signals and USB D+ and D- signals on different pins of the same connector. This avoids the need to use more complex circuitry, which would be required if, for example, the PS/2 signals were multiplexed on the same pin as either of the USB data signals. Further, the USB signals are balanced to reduce the radio emissions caused by high speed signaling and any degree of imbalance causes common mode signals which are a source of radio emissions which should be limited to defined safety levels. Hence, not multiplexing the PS/2 signals onto the same pins as the USB data signals helps to ensure that the balanced USB signals are not disturbed. Also, the separate microprocessors 142, 144 for the PS/2 and USB signals simplifies the design of the switch as the PS/2 and USB signals can be separately routed to the appropriate microprocessor. As all six pins of the mini-DIN connector are used, there is no 'spare' pin to 'jumper' the connector 310 which can be used to enable the microprocessors to detect the type of connection that has been made.

The microprocessors 144, 142 can automatically determine the type of connection (PS/2 or USB) that has been made so that

they can signal using the correct protocol. The KVMA switch detects when a wiring adapter has been connected rather than, for example, monitoring the characteristics of a computer port as these can vary and so detection may not be reliable.

The adapter 310 enables the microprocessors 144, 142 to detect the attachment of the adapter 310 by monitoring the behaviour of the signals on the PS/2 clock and data lines. The main microprocessor is permanently in communication with the PS/2 clock and data signal pins.

By linking the PS/2 clock and data lines to the ground line within the cabling adapter 310, the PS/2 clock and data lines are forced into a permanent low state. The controller microprocessor 142 within the KVM switch monitors the +5V signal from pin 4 to detect when a computer has been attached or powered on. Once it has detected this state it reads the state of the PS/2 clock and data lines from pins 1 and 5. If either of these lines is high then the microprocessor 142 assumes that a PS/2 connection has been made between the KVMA switch and the computer.

If a PS/2 connection has been made, then the PS/2 clock signal and PS/2 data signal should not both be low for more than about 150μs. Therefore the microprocessor monitors pins 5 and 1 to determine for how long both signals are low. If both signals are not low for more than 150μs then the microprocessor knows to expect PS/2 signals from port 184. However, if the adapter 310 is in use then the PS/2 data and clock signals are connected to ground. Therefore the microprocessor monitors pins 1 and 5 for about 200μs and if

it determines that both signals are low for more than 150µs it knows to expect USB data which can be obtained from pins 2 and 6. The microprocessor will then signal to the computer using whatever communication protocol has been detected.

Pins 2 and 6 can be connected to supply USB data signals directly to the USB microprocessor. Also the PS/2 data and clock signals can be supplied directly to the PS/2 microprocessor 142. Providing the USB D+ and D- signals and the PS/2 clock and data signals on separate pins simplifies the circuitry within the KVMA switch.

Cable 330 has standard PS/2 connectors on each end 234, 332. However, connector 332 cannot be directly connected to RS232 serial port 208 on computer 108. Another adapter 340 is provided. Figure 6 shows a wiring diagram for the pins of a PS/2 to RS232 adapter 340. Adapter 340 includes a standard 6-pin mini-DIN connector 344 at one end and a 9-pin D-type RS232 connector 346 at the other end. As can be seen, the clock and data pins (5 & 1) of the PS/2 connector are connected together. Further, the RS232 RXD pin (2) is connected to the PS/2 TXD pin (2), the RS232 ground pin (5) is connected to the PS/2 ground pin (3), the RS232 DTR and DSR pins (4 and 6 respectively) are connected together, the RS232 RTS pin (7) is connected to the PS/2 +5V pin (4) and the RS232 TXD pin is connected to the PS/2 -12V pin (6). The RS232 DCD, CTS and RI pins are not used.

Figure 7 shows a circuit diagram 700 of an interface for the computer ports 170,180 of the KVMA switch which is provided when the PS/2 to RS232 adapter is to be supported by the KVMA switch, e.g., as an interface for connector 180 in

figure 1. The interface circuit 700 is specifically for the adapter 340 shown in figure 6. However, other types of PS/2 to serial adapters have been provided previously with different wiring patterns for different dual PS/2-serial mice and suitable interface circuits are known in the art.

The adapter 340 connects the TXD (transmit data) pin of the serial port so that it is held at a negative level (typically -12V) when no data is being transmitted. This signal is fed via the adapter 340 and pin 6 of the mini-DIN connector 234 to the interface circuit 700 within the KVMA switch 104. This signal provides a negative voltage level to a BC807 PNP transistor 601 that is used by the circuit 700 to create a negative voltage level on the transmit data pin 602 that is used to transmit serial data from the KVMA switch 104 to the computer 108 via pin 2 of the mini-DIN cable 330 and the adapter 340. This signal is sent via the adapter 340 to the RXD pin 2 for the computer's serial interface.

Serial mouse data is generated by the microprocessor 142 and is presented to the interface circuit 700 as an inverted signal 603 with 0V and 5V signal levels. The transistor 601 inverts the signal and converts the 5V level of the input signal into a negative voltage level signal at the output pin 602. The negative voltage level is determined by the negative voltage signal supplied to pin 6 604 by the computer. The transistor 601 converts the 0V input signal level 603 into a positive voltage of approximately 5V at the TXD output pin 602. In this way the correct voltage levels

expected by the computer's serial port receive data pin 502 are generated.

Secondly the computer TXD signal enables the microprocessor 142 within the KVMA switch 104 to detect if a serial or PS/2 connection has been made to the computer. If a negative signal is not applied to pin 6 of the KVMA switch interface 700 then the signal level at point 605 will be at a logic high voltage level. If a -12V negative voltage is supplied to pin 6 then the signal at point 605 will not be at a logic high level. The microprocessor 142 monitors the state of signal 605 and determines if a PS/2 or RS232 connection has been made.

The RTS (request to send) signal from the computer's serial port is fed via pin 7 503 of the adapter 340 and pin 4 on the mini-DIN cable 330 to the KVMA switch's interface circuit 700. In this way, whenever a PS/2 or RS232 mouse connection is made, a logic high signal level can be detected by the microprocessor 142 on line 606. Upon detection of this signal, the microprocessor 142 monitors point 605 to determine the type of connection and then signals appropriately by either sending serial data or by signalling on the PS/2 lines 607 and 608.

The KVMA switch, cabling and adapters described provide a number of advantages. The KVMA switch requires only three connectors for each computer port in order to provide full keyboard, video, mouse and audio. This means that the KVMA switch can have a small size. For example, using the

invention, a KVMA switch can be constructed to fit within one unit of rack space (1U) with sufficient connectors for 8 computer ports presented on the rear panel.

For computers that do not support audio, or if a user does not want to use the audio signals, then non-customised, standard cables can be used with standard 15-pin D-type video connectors and 6-pin mini-DIN PS/2 type connectors. The pins used on the computer port video connectors and the signal conditioning circuitry does not interfere with the correct video operation of the switch and computer when standard cables are used.

If audio is required then as the combined video and audio cable uses a standard 15-pin D-type connector, the same three computer port connectors as a non-audio computer can be used. Although the combined video and audio cable is customized in terms of its connections within the hood of the D-type connector, the connector itself and the connectors at the computer end are standard. The combined audio and video cable can also be used to connect non-audio supporting computers to the KVMA switch. Therefore the combined video and audio cable is a universal part that can be used with any computer and KVMA switch having standard connectors.

Both the keyboard and mouse ports of the KVMA computer port are also standard PS/2 type connectors and so the keyboard and mouse cables are also standard and can be used with any PS/2 type connectors. However, through the use of the PS/2 to USB adapter, the KVMA switch can be attached to a USB port of a computer and the KVMA switch can automatically detect and handle USB rather than PS/2 signals and data.

The PS/2 to RS232 adapter also allows computers with RS232 serial ports to be used. Hence the adapters allow a broad range of computer keyboard and mouse ports to be supported using standard PS/2 connector cables and the adapters.

CLAIMS:

1. A cable for connecting a computer to a device having a standard video connector, the cable comprising:

a first standard video connector having video terminals and audio terminals at a first end of the cable for connecting to the device;

a second standard video connector having video terminals and a first audio connector at a second end of the cable for connecting to the computer;

a video signal transmission path between video terminals of the first and second video connectors; and

an audio signal transmission path between the first audio connector and audio terminals of the first standard video connector.

2. The cable of claim 1, wherein the audio signal transmission path provides a path for speaker signals to speaker terminals of the audio terminals.

3. The cable of claim 1, further comprising a further audio connector at the second end of the cable and a further audio signal transmission path between the second audio connector and audio terminals of the first standard video connector.

4. The cable of claim 3, wherein the further audio signal transmission path provides a path for microphone signals to microphone terminals of the audio terminals.

5. The cable of any preceding claim, wherein the first standard video connector is a 15 way video connector.

6. The cable of any preceding claim, wherein the audio terminals include at least one terminal corresponding to a video display data signal terminal.

7. The cable of any preceding claim, wherein the audio terminals include a terminal corresponding to a power supply terminal.

8. The cable of any preceding claim, wherein the audio terminals include a terminal corresponding to a ground terminal.

9. The cable of any preceding claim 4, wherein the audio terminals include a first audio channel terminal, a second audio channel terminal and an audio ground terminal.

10. The cable of claim 9, wherein the microphone terminals include a microphone signal terminal and a ground terminal common with the audio ground terminal.

11. The cable of claim 1, wherein the first standard video connector has a video ground terminal and a separate audio ground terminal.

12. The cable of claim 1, wherein there is no signal path between a video terminal of the second standard video connector corresponding to a ground terminal and the first standard video connector.

13. The cable of claim 1, wherein video terminals of the second standard video connector corresponding to a video display data signal terminals are connected to a ground terminal of the second standard video connector.

14. A method for transmitting video and audio signals between a computer and a device having a standard video connector, comprising:

providing a video signal transmission path between a computer video connector and video terminals of a standard video connector; and

providing an audio signal transmission path between an audio connector and audio terminals of the standard video connector.

15. The method of claim 14, further comprising providing a further audio signal transmission path between a further audio connector and audio terminals of the standard video connector.

16. The method of claim 15, wherein speaker signals are provided over the audio signal transmission path and microphone signals are provided over the further audio signal transmission path.

17. The method of claim 14, wherein the video terminals and the audio terminals of the standard video connector have separate ground terminals.

18. The method of claim 17, wherein the audio ground terminal is common to different audio signals.

19. The method of claim 14, wherein the audio terminals include at least one terminal corresponding to video display data signal terminal.

20. The method of claim 14, wherein the audio terminals include at least one terminal corresponding to a power supply terminal.

21. An electrical apparatus for handling video and audio signals, the apparatus including:

a standard video connector having video terminals and audio terminals; and

video signal handling circuitry and audio signal handling circuitry, in which the video signal handling circuitry is connected to the video terminals of the standard video connector and the audio signal handling circuitry is connected to the audio terminals of the standard video connector.

22. The apparatus of claim 21, in which the audio signal handling circuitry is connected to at least one audio terminal corresponding to a video display data signal terminal.

23. The apparatus of claim 21, wherein the standard video connector has a video ground terminal and a separate audio ground terminal.

24. The apparatus of claim 21, wherein the standard video connector has an audio ground terminal common to two different audio signals.

25. The apparatus of claim 21, wherein the standard video connector is a 15 way video connector.

26. A system comprising a computer having a video connector and at least one audio connector connected to a device as

claimed in any of claims 21 to 25 by a cable as claimed in any of claims 1 to 13.

27. A KVMA switch including:

video signal switching circuitry;

audio signal switching circuitry; and

at least one computer port comprising a mouse connector, a keyboard connector and a standard video connector, in which the standard video connector includes video terminals in communication with the video signal switching and audio terminals in communication with the audio signal switching circuitry.

28. The KVMA switch of claim 27, further comprising a peripheral port, including a video connector, a keyboard connector, a mouse connector, a speaker connector and a microphone connector.

29. The KVMA switch of claim 27, in which the computer port consists of the mouse connector, keyboard connector and a standard video connector.

30. The KVMA switch of claim 27, in which the KVMA switch includes a plurality of computer ports, each consisting of a mouse connector, a keyboard connector and a standard video connector.

31. An adapter, comprising:

a PS/2 style connector at a first end; and

a USB style connector at a second end, in which terminals of the PS/2 connector corresponding to PS/2 data and clock signals are connected to a ground terminal of the USB connector.

32. A method for determining whether a PS/2 or USB device is connected to a PS/2 style connector, comprising:

monitoring the signals on terminals of the PS/2 style connector corresponding to the PS/2 data signal and the PS/2 clock signal; and

determining that a PS/2 device is not connected to the connector if the PS/2 data signal and PS/2 clock signals are the same for a threshold period of time.

33. The method of claim 32, in which the PS/2 data and clock signals are both determined to be low.

34. The method of claim 32, wherein the threshold period of time is greater than substantially 150 microseconds.

35. A video and audio cable with a standard video connector substantially as hereinbefore described.

36. A KVMA switch substantially as hereinbefore described.

37. An adapter for use between PS/2 and USB connectors substantially as hereinbefore described.

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Claims searched:	1 to 26	**Date of search:**	6 February 2004

Patents Act 1977 : Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1 to 3, 5 to 8, 12, 14, 15, 19 to 22, 25 and 26	WO99/60464 A1 SEGA See abstract and figures 2, 3, 6 and 9

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